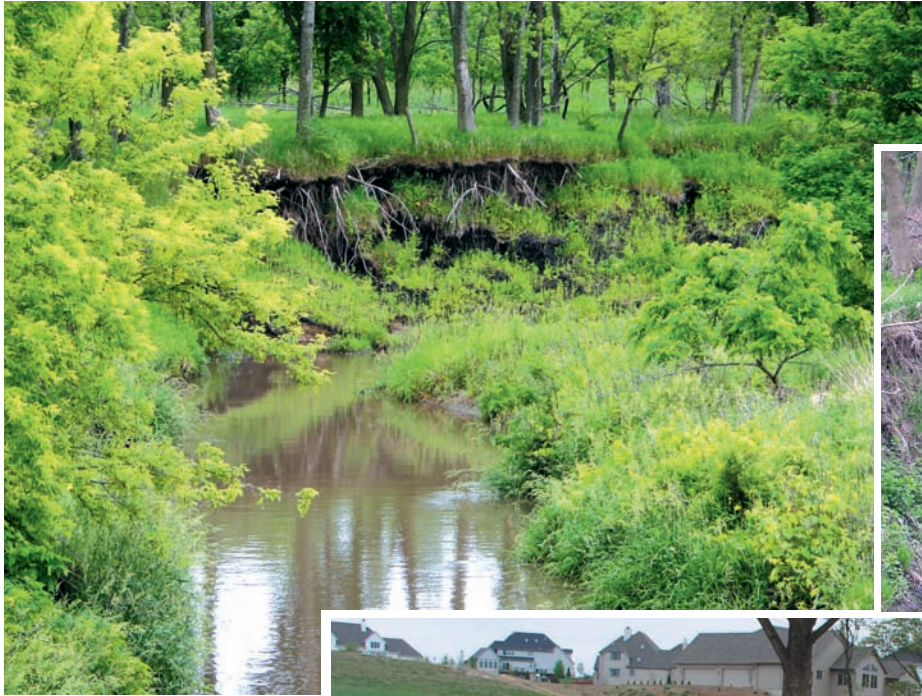


How to Control Streambank Erosion

Updated 2006



Iowa Department of Natural Resources

HOW TO CONTROL STREAMBANK EROSION

Prepared by the
Iowa Department of Natural Resources
In cooperation with the
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DISCLAIMER

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INTRODUCTION

This manual is intended to assist private property owners, developers, and contractors in selecting materials and methods to control streambank erosion. It is not meant to be all-inclusive, but provides information on a number of alternative methods for controlling streambank erosion and focuses on methods that are applicable to Iowa and other Midwestern states. For each method, the manual contains information describing the overall method, its advantages and disadvantages, materials needed, and site preparation and installation requirements. Where possible, photos have been provided to assist the user in visualizing the method and its implementation.

The manual describes both structural and bioengineering methods of streambank erosion control. Structural methods use steel, wood, rock or other aggregate, concrete, or a combination of these materials to protect the streambank. Bioengineering methods use grasses, trees, or other living plants to restore natural streambank protection. In many cases, a combination of structural and bioengineering practices are used.

The manual is not intended to be a step-by-step book. Rather, it is intended to provide basic information about alternative approaches that should be considered in planning a streambank protection project. The information in this manual may be adequate to allow landowners to carry out relatively simple streambank protection projects on small streams without additional assistance. For more complex projects, assistance may be needed from a licensed engineer or other professional with experience in this type of work. Sources of assistance may include the following:

- Iowa Department of Natural Resources (Iowa DNR), Flood Plain Permits Section/Sovereign Land Section (Des Moines, Iowa: 515-281-8693). This group can also provide advice about the necessary permits to be obtained prior to construction of the bank protection.
- Natural Resources Conservation Service (NRCS) (515-284-6655).
- U.S. Army Corps of Engineers (Rock Island, Iowa: 309-794-5376; Omaha, Nebraska: 402-221-4133).
- United States Fish and Wildlife Service (309-793-5800).
- Consulting Engineers Council of Iowa (Des Moines, Iowa, phone: 515-284-7055; fax: 515-284-7301). This organization can direct property owners to a local consultant who can assist in the design and construction supervision of such projects.
- Land Improvement Contractors Association of Iowa (LICA). This organization has members across the state to carry out such work.
- Iowa Department of Agriculture and Land Stewardship/Division of Soil Conservation (515-281-5851).

HOW TO CONTROL STREAMBANK EROSION

To use this manual properly, one must have a basic understanding of why erosion is occurring, the physical and legal constraints in correcting the erosion problem, and the actions an individual can take to correct the problem. In many cases, the solution to the third problem may be to seek professional help in the design and installation of streambank erosion control measures.

What is Streambank Erosion?

Erosion is the removal of soil particles from a site due to the forces of water, wind, and ice. Over time, these forces will slowly wear away or disintegrate the soil. In the case of a stream, erosion may occur in several ways, identified below.

Erosion of streams in agricultural areas normally occurs as a result of one of three factors: change in stream flow, water flowing over or through the streambank, and the discharge of concentrated runoff from other sources. Iowa's streams are subject to wide fluctuations in both flow depth and velocity over a period of years, due to normal seasonal changes in rainfall and large single-storm events. As flow depths and velocities increase, the force of the water flowing against the streambank removes soil particles from the banks, and in many cases erosion causes banks to slump and fall into the flowing water. In extreme situations where high flows persist over long periods, banks may erode several feet annually. Rain falling on streambanks or runoff from adjacent fields that enters a stream by flowing over the streambanks can also erode soil from streambanks, particularly if banks are inadequately protected. Finally, water discharged into a stream from tributary drainage systems (such as waterways or tile lines) can also erode streambanks, particularly if the water is discharged in an area where the bank is unstable and highly erodible. In many cases, moving the outlet to a point where the stream is less erodible or stabilizing the outlet area with rock can alleviate this problem.

Although a stream channel may appear to be stable, when viewed over a period of decades or centuries most streams exhibit a tendency to adjust or shift location. In some instances, changes result from single events, such as a tree falling into a stream and deflecting the flow of the water. In other instances, these changes are due to differences in soil type and structure within the stream channel or are the result of erosion occurring from catastrophic storm events. Any straight stream channel will eventually erode on portions of each bank and begin to bend or meander. As the stream bends become longer and more sharply curved, more soil is eroded from one side of the channel and deposited on the other side of the channel.

Streambank Erosion Control Planning Considerations

Erosion control projects should be planned carefully to achieve a successful result. The following factors should be considered before starting a streambank erosion project:

- Can erosion of the bank be reduced through conservation measures near the stream? In some cases, a landowner may be able to reduce bank erosion by using the following practices:
 - Farm no closer than 75-90 feet from the edge of the streambank and establish permanent-type vegetation in this area identified as a buffer strip (see Riparian Buffers section).
 - Do not place excessive weight on the top of the bank in the 15-foot-wide strip nearest the stream. Do not make this a place for disposing of debris from the surrounding land or as a travel lane for vehicles or farm equipment.
 - Restrict or eliminate livestock access to the streambank or buffer zone. If possible, use off-stream watering sources to provide water to livestock. If this is not possible, restrict watering to specific locations where adequate streambank protection exists.
 - Remove fallen trees or other debris from the stream if debris is causing bank erosion problems. However, because trees often improve aquatic habitat conditions in streams, removal should be avoided when possible.
 - If seepage through the streambank is causing bank erosion, consider installing a subsurface drain system to intercept this drainage before it reaches the stream.
- Are nearby landowners also having problems with streambank erosion on this stream? If so, how have they dealt with the problems, and how can their successes or failures provide ideas about how to address specific problems? If other landowners are not experiencing problems, how are they managing the stream and adjacent lands differently, and would changing management practices solve the problem in question?
- Will the actions taken to solve a streambank erosion problem affect upstream or downstream landowners or public facilities such as roads or bridges? Any steps taken to solve a specific problem should be consistent with being a good neighbor and steward of the land. The entire stream should be considered as a system, and any project should consider impacts to the total system, not just on a single property.
- When will the site conditions be most suitable for carrying out the planned project, and how can construction activities be conducted to minimize stream impacts and maximize the safety of the individuals doing the work? Generally, construction activities should be planned for those periods of the year when stream flows are lowest. In some cases, certain activities may need to be carried out at other times of the year, particularly if the project involves planting trees or grasses.
- Can and should the work be carried out by the landowner or other private party, or does the project require specialized skills or equipment that should only be used by a qualified contractor? Working in or near a stream poses special safety

hazards, particularly if the stream has steep or high banks or the stream velocity is high. Where these conditions exist, using a contractor who has the needed equipment and experience is recommended.

- Are there permits and regulations that need to be obtained or considered before beginning? (see Permit Regulations section)
- How will this project affect the habitat of the fish and wildlife in and around the stream? Many of the methods covered in this manual can enhance habitat conditions within and adjacent to the stream.
- How much will the project cost, and will the benefits be sufficient to justify this cost? In many cases, the most severe streambank erosion problems occur on Iowa's larger streams. Unfortunately, due to the volume and velocity of the water carried in these streams, the cost of controlling erosion on these streams is also extremely high, and can generally only be justified if the erosion threatens a building, bridge, or other similar structure.

Streambank Erosion Control Design and Construction Considerations

- Who will design the system and select the materials? For many of the methods illustrated in this manual, a professional engineer or person from the agencies listed above has the required specialized knowledge to design the system and can assist in the selection of the materials to be incorporated. Some of the materials identified in the manual are for use in specific restoration situations. Recommendations on alternative materials can be obtained through the Iowa DNR, NRCS, design consultants, LICA of Iowa, and through contractor supply companies in Iowa. When considering bioengineering materials, pay attention to materials readily available near the site or known to grow well along other streams in the area.
- Will the work be done by a contractor or by the landowner? The primary consideration in this decision is the safety of those working on the project. Consideration must be given to the velocity of the stream, depth of the stream at construction, slope and height of the bank, and the soils contained in the bank.
 1. Stream velocity: Erosion can occur under any stream velocity, but becomes evident at velocities of greater than three feet per second. Velocities greater than three feet per second can pose safety concerns for workers as the depth of the stream increases. Erosion control work in areas with high water velocity requires special skills and equipment, usually only found with contractors.
 2. Depth of stream: Depths of up to three feet allow individuals to work at the water's edge without special equipment. At depths in excess of three feet and velocities in excess of three feet per second, manual labor can become dangerous. Use of contractors should be considered for this type of work.
 3. Bank slope: Slope is measured in terms of the horizontal distance from the top of the bank, toward the stream, for every one foot drop in elevation to the surface of the slope. Slopes of six feet horizontal to one foot vertical (6H: 1V) or flatter can be worked with landowner equipment, provided the total bank

height is less than four feet. Streambank protection activities on slopes steeper than 6H: 1V (ex. 1H: 1V to 5H: 1V) should only be conducted using specialized equipment, normally found with specialty contractors.

4. Bank height: The height is the difference in elevation between the top of the bank and the water at the low flow elevation. Property owners should only consider restoration of bank heights of less than four feet and with slopes as noted in item 3. Greater bank heights should be designed for restoration with a contractor's specialized equipment and knowledge.
5. Soils: Soil classifications for the materials present in the banks can be determined from the NRCS. Soil survey maps can be found in each Iowa DNR or NRCS office for the specific location (<http://www.ia.nrcs.usda.gov/>). This is the point where public agencies can help identify soils or other conditions that would be unsafe to operate motorized equipment over.
6. Volume of work to be accomplished in the streambank project: The property owner or developer must estimate the amount of time, materials, equipment, and labor necessary to complete the work as compared to those personally available. This is a subjective decision based on time, knowledge, and resource constraints.
 - a. Construction activities should be conducted during periods of low flow.
 - b. Construction equipment, activities, and materials should be kept out of the water to the maximum extent possible.
 - c. All construction debris should be disposed of on land in such a manner that it cannot enter a waterway or wetland.
 - d. Equipment for handling and conveying materials during construction should be operated to prevent dumping or spilling the material into water bodies, streams, or wetlands.
 - e. Care should be taken to prevent any petroleum products, chemicals, or other deleterious materials from entering water bodies, streams, or wetlands.
 - f. Clearing of vegetation, including trees located in or immediately adjacent to waters of the state, should be limited to that which is absolutely necessary for construction of the project. All vegetative clearing material shall be removed to an upland, non-wetland disposal site.

Table 1 provides information that can be used to help select the streambank stabilization methods that are most appropriate for a given situation. Note that there may be several alternatives that meet the needs of a specific location. Each may be different in terms of types of materials used and cost of the design and installation. The property owner or developer must consider all of the criteria associated with the site and then employ the appropriate method. The decision may also involve considering successful operations done on adjacent portions of the streambank or considering ways to provide a certain aesthetic value to the area.

Table 1. Diagnosis of appropriate streambank stabilization methods

Method	Description	*Bank erosion problem	Stream velocity	Stream depth	Bank slope	Bank height	Constr. cost	Maint. cost
Seeding of streambank	Planting of grasses on a streambank to reinforce a bare streambank.	1, 4	0-3 ft/sec	Any	>6:1	<4 ft & >4 ft	Medium	Low
Live stakes	Placement of woody plant and tree cuttings on a graded bank to grow and stabilize the bank by the formation of roots and above-ground growth.	1, 2, 4	0-3 ft/sec & >3 ft/sec	Any	<6:1	<4 ft & >4 ft	Medium	Medium
Joint planting	Combination of covering a streambank with rock and live stakes.	2, 3, 4	>3 ft/sec	Any	<6:1	>4 ft	High	Low
Live fascine	Placement of bundles of branches in trenches to slow over-bank erosion and establish structural soil stability.	4	0-10 ft/sec	Any	>6:1	>4 ft	High	Low
Brush-mattress	Combination of riprap, live fascine, live stakes, and brush to form a covering over the entire slope.	1, 2, 4	>3 ft/sec	Any	<6:1	>4 ft	High	High
Live cribwall	Combination of timbers, live branches, soil, rocks, and logs to fill a bank and eventually establish a root network.	1, 2, 3	>3 ft/sec	Any	<6:1	>4 ft	High	Low
Branch-packing	Layering of live branch cuttings and compacted soil to fill small holes and slumps of a streambank.	3	>3 ft/sec	Any	<6:1	>4 ft	High	High
Coconut fiber rolls	Cylindrical structures made of coconut husk fibers bound together with coconut husk twine.	1, 2, 4	0-10 ft/sec	Any	>6:1	<4 ft	Medium	Medium
Log, rootwad, and boulder revetment	Logs are placed in the stream and held in place by boulders. The rootwads are then placed around the boulders to slow the flow of the stream, protect the bank, and provide habitats for fish and wildlife.	1, 3, 4	>3 ft/sec	Any	<6:1	<4 ft & >4 ft	High	Low
Tree revetment	Placement of trees along the eroding streambank.	1, 3, 4	>3 ft/sec	Any	<6:1	>4 ft	High	Medium
Dormant post planting	Placement of medium-sized trees in the slope next to the stream.	1, 2, 4	>3 ft/sec	Any	>6:1	<4 ft & >4 ft	Medium	High
Piling with wire or geotextile fencing	Single or double row of pilings with mesh, wire, or geotextile on the streamside of the fence.	1, 3, 4	>3 ft/sec	Any	<6:1 & >6:1	>4 ft	Medium & High	Medium

Table 1. (continued)

Method	Description	*Bank erosion problem	Stream velocity	Stream depth	Bank slope	Bank height	Constr. cost	Maint. cost
Riprap	Layer of various-sized rocks used to protect a streambank from erosion.	1, 2, 3, 4	>3 ft/sec	Any	<6:1 & >6:1	<4 ft & >4 ft	High	Low
Jetty system	Dike-like structure from the streambank out into the streambed.	1, 3, 4	>3 ft/sec	Any	<6:1 & >6:1	>4 ft	High	Low
Iowa vanes	Vanes placed in the eroding streambed that cause the flow to be redirected and result in the recollection of sediment on the bank.	1, 4	>3 ft/sec	Any	<6:1 & >6:1	>4 ft	Medium	Low
Vegetated geogrids	Combination of geotextiles, rock fills, and live materials.	1, 3, 4	>3 ft/sec	Any	<6:1	>4 ft	High	Low

*Bank Erosion Problem: 1 = Fast flowing streams with erodible soils 3 = Fill structure for holes in streambank
 2 = Extensive toe- and stream-level erosion 4 = Resistance to occasional heavy flows

Streambank Erosion Control Maintenance

Each of the methods described in this manual requires observation and maintenance of the streambank erosion control practices over time. Observations should be made on a regular basis prior to and after major stream flow events. Maintenance activities should include the following:

1. Removal of any debris that becomes entangled in the erosion control material and could damage the bank materials.
2. Replacement of missing or damaged erosion control materials during times of low stream flow.
3. Application of fertilizer to plant materials to enhance their growth each year.
4. Application of fertilizer and weed control to buffer strip vegetation.
5. Restriction of livestock from steep banks and the areas containing the erosion control measures.

Riparian Buffers

While completing an erosion control project, other factors can be considered to improve the water quality, riparian habitat, and the overall ecological health of the stream system. The use of riparian buffers is a popular method to increase the quality of water resources. The United States Department of Agriculture (USDA) offers an excellent booklet entitled “Riparian Forest Buffers: Function and Design for Protection and Enhancement of Water Resources,” which provides detailed information about the benefits and specifications of riparian buffers that will only be summarized here.

Refer to http://www.na.fs.fed.us/spfo/pubs/n_resource/riparianforests/ for the complete online booklet. The USDA defines a riparian forest buffer as

An area of trees and other vegetation located in areas adjoining and up gradient from surface water bodies and designed to intercept surface runoff, wastewater, subsurface flow, and deeper groundwater flows from upland sources for the purpose of removing or buffering the effects of associated nutrients, sediment, organic matter, pesticides, or other pollutants prior to entry into surface waters and groundwater recharge areas.

Specifically, riparian buffers provide the following benefits:

- Help cool the stream temperature, which improves insect and fish habitat.
- Establish complex root system from trees, shrubs, and grasses, which helps retain soil.
- Naturally removes phosphorous and nitrogen products from runoff water.
- Increases infiltration of water into the soil and slows the runoff.
- Decreases stream sediment load.

Riparian buffers consist of three zones, a zone of stabilization at the stream edge, a tree and shrub area, and an area of dense grasses. Drainage tiles or pipes passing through riparian buffers should be minimized. Water that is normally carried through tiles or pipes should be allowed to flow through the buffer area to be naturally filtered and infiltrated and to allow for the removal of pollutants. The first zone next to the stream should be 15 feet wide, measured perpendicular to the stream. This zone can be comprised of the vegetation used in stream stabilization methods discussed in this manual. The second zone consists of an area with a minimum width of 60 feet, measured wide and on the land side of the first zone. It consists of trees, shrubs, and their litter of leaves and branches as an energy source to capture agricultural chemicals that pollute streams. Livestock should be restricted from zones one and two. Maintenance of zones one and two, especially after very high stream flows, is necessary. Zone three should be approximately 25 feet wide and contain natural grasses. This zone is an important area for infiltration of water during heavy storms. Livestock grazing over zone three should be limited to ensure adequate grass cover.

The above description only outlines the minimum requirements and dimensions of a riparian buffer strip. Some riparian forest buffers can be up to 300 feet in width. More detailed information can be obtained from the Iowa DNR or the USDA Forest Service.

Permit Regulations

Prior to beginning any streambank erosion control construction, the property owner should contact the Iowa DNR to determine the need for a special permit for the construction or use of special materials. Approval may be required from the DNR and the United States Army Corps of Engineers. The same application form is used for both agencies and can be obtained from the following:

**Iowa Department of Natural Resources
Flood Plain Permits Section/Sovereign Land Section
Wallace State Office Building
900 East Grand Avenue
Des Moines, IA 50319-0034
Telephone: (515) 281-8693**

**District Engineer
U.S. Army Engineer District, Rock Island
Regulatory Functions Branch
Clock Tower Building
Rock Island, IL 61204-2004
Telephone: (309) 794-5376**

The DNR typically has the following permit conditions for the types of materials used in the project:

- **Riprap.** It should consist of native field stone, quarry run rock, or clean broken concrete. If broken concrete is used, all reinforcement material shall be completely removed from it; if removal is not possible, the reinforcement material should be cut flush with the surface of the concrete. The riprap must be maintained free of exposed reinforcement material. The concrete pieces shall be appropriately graded and no piece shall be larger than three feet across the longest flat surface. No asphalt or petroleum-based material shall be used as or included in riprap material.
- **Lumber.** Wood products used in the construction of the project shall be limited to only water-based treated lumber; no creosote- or petroleum-treated lumber shall be permitted.

SEEDING OF STREAMBANK

Establishing vegetation on streambanks is frequently the simplest way to stabilize the soil and slow erosion. Where erosion is not severe, the banks can be seeded with warm or cool season grasses and legumes. Live tree cuttings can be inserted in the ground to give greater bank protection over a longer period of time.

Advantages and Disadvantages

- Seeding is useful when rich topsoil is readily available.
- Vegetation improves the appearance of streambanks.
- Seeding is low-cost, particularly when compared to structural erosion control methods.
- Seeding should be part of all projects, including those making use of more complex structural erosion control methods.
- If used alone, seeding may not be adequate to control bank erosion, especially when erosion is severe.
- Seeding must be done during low flow conditions, and vegetation must have sufficient time to grow before high flow conditions occur. If the bank is seeded shortly before a high flow event, the roots may not be strong enough to keep the plants and soil from washing away.
- Seeding is generally not suitable for stabilizing the toe of a streambank, as few plants will survive below water level. See the Willow-Post method for using trees to stabilize bank slopes at the edge of the waterline.



Figure 1. Streambank that has been graded and seeded using a natural fiber blanket containing seed

Materials

Seed mixture recommended by Iowa Department of Transportation:

Alsike clover	5 lbs/acre
Fawn fescue	30 lbs/acre
Switchgrass	10 lbs/acre
Birdsfoot trefoil	5 lbs/acre

Preparation

- Regrade the slope no steeper than six feet horizontal to one foot vertical (6H: 1V). Always regrade by pulling dirt away from the stream to minimize the amount of soil discharged into the water.
- Check with the DNR prior to any flood plain disposal of spoil material resulting from the streambank grading.
- If the regraded bank does not contain adequate topsoil to support good vegetative growth, topsoil should be placed on the slope as needed.
- Additional bank stabilization can be obtained by installing a buffer strip of trees, shrubs, and grasses adjacent to the streambank.

Installation

There are several ways to apply the seed to the bank:

- A liquid seed mixture can be sprayed on the bank.
- The seeds can be evenly thrown on the bank and then covered with one-half inch of soil and lightly tamped to ensure contact with the soil. Straw or other suitable mulching material can also be used to provide initial bank stabilization and speed plant growth.
- Commercial seed mats can be used, giving more initial stabilization of the streambank (see Figure 1) and faster establishment.
- If increased vegetative growth is necessary, the slope can be treated with nitrogen in a 30-lb/acre application during the next growing season.



Figure 2. Seeded bank after a few months of growth